## Percentage of Patients with Cardiac Electronic Devices Requiring Magnetic Resonance Imaging

Magnetic resonance imaging (MRI) is a very useful imaging procedure for the diagnosis of several conditions, and it is estimated that 50-75% patients with pacemakers will have an MRI indication over their lifetime. (1) Magnetic resonance imaging is contraindicated in non-compatible cardiac stimulation devices as established by their manufacturers and by the Food and Drug Administration (FDA). While there are MRI-compatible pacemakers, the vast majority of the devices are not currently certified as compatible. The purpose of our research work was to determine the percentage of patients with devices who required or underwent an MRI as part of the diagnosis or treatment of certain cardiac or extracardiac conditions.

An observational and retrospective study was carried out on patients with cardiac stimulation devices who underwent the corresponding clinical monitoring between January and October 2019. Information was collected since the implantation of the cardiac stimulation device and during follow-up until the last consultation.

Data about gender, age, type of device (pacemaker, cardioverter defibrillator or resynchronization device) and also whether or not it was compatible or conditional for MRI, were collected from the electronic medical records. The evaluated endpoint was MRI request between device implantation and the last control, or the presence of a condition that would have required MRI for its management, arbitrarily defined by researchers as neurological disorders (stroke, seizures, tumors, metastasis), trauma injuries (spinal cord, knee, ankle or shoulder involving tendons), cardiac diseases (suspected myocarditis, hypertrophic or infiltrative cardiomyopathy) or oncological conditions (suspected metastasis).

Estimated sample size was approximately 310 patients, considering that the proportion of patients with MRI in international registries is about 28%, with an alpha error of 95% and an accuracy of 5%. Categorical variables were expressed as percentage and continuous variables as median and interquartile range. SPSS 17 statistical package (SPSS, Inc., Chicago, IL, USA) was used for statistical analysis.

The study was approved by the Institutional Research Committee and ethical considerations were in compliance with the Declaration of Helsinki.

A total of 374 patients underwent device clinical monitoring at the Department of Electrophysiology and Arrhythmia of Hospital Privado Universitario de Córdoba during the period analyzed. Seventy-four patients were excluded from the study either because they were duplicates or were not followed up at our institution.

Finally, 300 patients (80.2%) were analyzed. Median age was 74 years (interquartile range 64-82 years) and 38.7% were women. A total of 71.9% of patients had pacemakers, and the rest other devices. In 68% of cases patients had 2 implanted leads and 3.7% had some abandoned lead; 47% had pacemaker-dependent heart rhythm (complete AV block), and 23.4% had an implanted cardioverter defibrillator with or without a resynchronization device. The percentage of MRI-compatible devices was 14.3%.

Follow-up was 941 days (interquartile range 281-2,252 days). During that period, 5 MRIs were performed (1.7%) and there were 50 patients (16.6%) with conditions that could have required an MRI for diagnosis or treatment (Figure 1). The 5 patients in whom MRI was performed had an MRI-compatible pacemaker in 80% of cases and 40% of these patients had pacemaker-dependent heart rhythm. Among the patients with conditions that could have required MRI, 16% had an MRI-compatible device (Table 1).

The main finding of this study has been the low use of MRI in our population with electronic cardiac

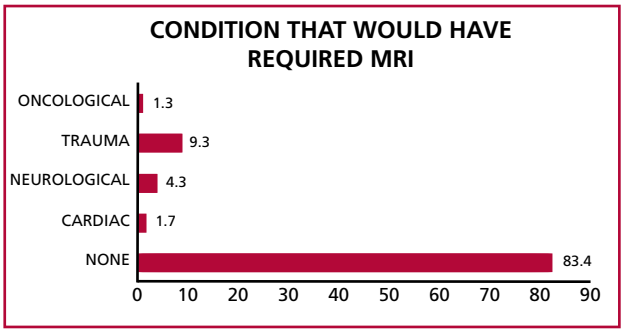


**Fig. 1.** Proportion of patients with MRI request or conditions requiring MRI

**Table 1.** MRI in Population

| | |
|---|---|
| Performed MRI | MRI-compatible device (80%). MRI-non-compatible device (20%).<br>In patients with PM (100%)<br>PM-dependent heart rhythm (40%). Non-dependent (60%) |
| Potential MRI | MRI-compatible device (14.3%). MRI-non-compatible device (85.7%).<br>PM (71.9%) ICD (23.4%) RC (4.6%)<br>PM-dependent heart rhythm (47%). Non-dependent (53%) |

PM: Pacemaker. ICD: Implantable cardioverter-defibrillator. RC: Resynchronization device. MRI: Magnetic resonance imaging.

stimulation devices. Current experience reports that the use of MRI in this population is approximately 20-30% (2), very similar to the potential need for MRI in our cohort. Magnetic resonance imaging is the primary tool for the evaluation of patients with neurological and muscular diseases, tumors, and some cardiovascular disorders, and it is estimated that the probability of a patient being indicated an MRI after the implantation of an electronic device may reach 75%. (1)

The first pacemakers were devices with a large surface area and presented alterations when an MRI was performed, so the FDA and device manufacturers did not recommend its use in patients with implanted pacemakers. Further studies have demonstrated that MRI could be performed with no significant clinical effects and no differences in the type and number of complications in patients who had a pacemaker that was non-MRI-compatible compared with patients with MRI-compatible devices, taking the necessary precautions and applying a safety protocol. (3, 4)

This protocol consists in programming the pacemaker to an asynchronous pacing mode in pacing-dependent patients, or inhibiting it (turning it off) in non-pacing-dependent cases, and in the inhibition of tachycardia monitoring and deactivation of therapies in patients with defibrillators. (4)

The theoretical risks of MRI in non-compatible device carriers are lead heating, reprogramming with loss of capture, and sensing or developing arrhythmias. (5) However, two recently published studies that included more than 2,500 patients who received MRI with 1.5 T scanner showed no significant complications applying the safety protocol. (3, 4) It should be pointed out that devices implanted before certain dates (pacemakers prior to 1998 or defibrillators prior to 2000) were taken as contraindication in these studies.

In our experience, only 3 devices predated the year 2000. Fractured, epicardial, and abandoned leads seem to be very susceptible to heating. (6) In our experience, a patient with abandoned lead received an MRI with no adverse events.

The study limitations include its retrospective and single-center nature. There may be a selection bias, since a large proportion of the patients included had their device implanted in recent years; therefore, their follow-up period was shorter and the likelihood to require an MRI was lower. On the other hand, a possible explanation for the low utilization of MRI in this study could be that the Imaging Service in our center does not perform cardiac MRI, so there is little experience in managing cardiovascular conditions and having an implanted cardiac stimulation device is still considered a contraindication.

In conclusion, MRI utilization in a population with cardiac-stimulation devices is low. Knowing and disseminating safety protocols is important, since more MRIs could be performed without significant clinical effects.

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**Conflicts of interest**

None declared.

(See authors' conflicts of interest forms on the website/ Supplementary material).

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## Transesophageal Echocardiography in the Era of COVID-19. Use of the Aerosol Box as an Additional Barrier

Coronavirus infection (COVID-19) is an acute -sometimes severe- respiratory disease caused by a new SARS-CoV-2 coronavirus. The rapid progression of this virus has collapsed first-world health systems. This leads us to act responsibly and swiftly in designing organization and action strategies to address this pandemic with as many resources as possible. (1)

Protecting healthcare personnel and preventing SARS-CoV-2 transmission should be a priority during this COVID-19 pandemic. Given the high infec-